Lat 40.62382 Lon -121.62076

Forest Health Protection
Pacific Southwest Region

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To: District Ranger, Hat Creek RD, Lassen National Forest

Subject: *Heterobasidion* root disease and dwarf mistletoe in Sluice Box Project stands #106 and #991 (FHP Report #NE13-6)

On June 4th, with Lauren Payne (VMS Enterprise Team), Bill Woodruff (FHP Plant Pathologist) evaluated stands #106 and #991 in the Sluice Box Project for *Heterobasidion* root disease (Sec. 15 T32N, R3E, Mt. Diablo Meridian; Latitude 40.623818; Longitude -121.620755) . The unit is a generally well-stocked pine and fir stand with very large Jeffrey pine, white fir and red fir trees growing above mostly true fir of all sizes. Management direction allows removal of trees under 30" DBH throughout the unit and a limited number of small group selections. The intent is to place the group selections in places where root disease is most damaging.

Figure 1. *Hetreobasidion occidentale* fruiting bodies from an old fir stump in the Sluice Box project.

Fruiting bodies (conks) of *Heterobasidion occidentale* (Figure 1) and delaminated wood (Figure 2) were readily found in fir stumps or wood of upturned roots in the stands, thus confirming that *Heterobasidion* root disease is present. Also, true fir dwarf mistletoe is growing in many fir trees of all sizes in the unit. The inability to harvest any tree larger than 30" DBH limits the control options for either the root disease or the dwarf mistletoe infestation.

Figure 2. Decayed wood from a fir stump showing delamination of the growth rings. Wood separating at the growth ring is a decay symptom of advanced decay in confer roots infected with *Heterobasidion* and other fungi.

Other symptoms of root disease found in the true fir in the unit are declining crowns (dead branches and sparse foliage), stunted tree growth (e.g. short leader growth and rounded tops), and windthrow. Even though these symptoms could be readily found in the unit, the crowns of the fir in most of the unit appeared

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relatively healthy. Only a few small areas in the unit exhibited symptoms of advanced root disease (i.e. fir snags, blown-down fir trees, decayed root and stump wood, short leader growth on understory fir trees, or seriously declining old-growth crowns). The areas in the unit with the most disease signs and symptoms would be the best places to clear and plant with pine (group selections). The disease in remainder of the unit could be satisfactorily treated by removing understory trees with poor crowns (short leader growth, heavy dwarf mistletoe or decline); thereby using individual tree selection to remove trees most impacted by disease; reducing tree densities and improving the growth and vigor of the leave trees. Note, sanitizing these stands in this way will not eliminate the root disease or dwarf mistletoe in these stands. Many trees with light dwarf mistletoe or little root disease will remain after treatment. However, the impact of the diseases on these trees will be reduced because the residual trees will get more sunlight and soil moisture; and grow with increased vigor. Fast-growing trees can usually grow new wood in the roots and lower bole faster at than *Heterobasidion* can decay the interior wood in infected parts of a tree. Also, fast-growing fir crowns can usually out-pace the spread of dwarf mistletoe as long as seed from dwarf mistletoe in overstory trees don't result in many new infections.

Considering the overstory trees in these stands, an effective treatment for improving the growth and vigor of old growth pine and fir trees is 'radial thinning' where understory trees are cleared from around residual old growth trees at least as far as the trees' 'drip-lines'. Radial thinning could be effectively implemented in the Sluice Box Project to improve the health of many of the old growth trees. However, the health of old growth trees with poor vigor and declining crowns (i.e. heavily impacted by root disease or dwarf mistletoe) will probably not be improved. All overstory trees, under 30" DBH, with poor crowns and conifer regeneration in the understory, should be removed to increase the health and vigor of the understory trees. Most overstory old growth fir trees with seriously declining crowns retained in the stands following treatment will probably die in the near future. After dying they will slowly decay and collapse. In the interim, these large snags will benefit wildlife and soil health.

For more information on *Heterobasidion* root disease or dwarf mistletoe, see the attached. If you have any questions regarding this report and/or need additional information please contact Bill Woodruff at 530-252-6680.

/s/ Bill Woodruff
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Heterobasidion Root Disease

Heterobasidion spp. is a fungus that attacks a wide variety of woody plants worldwide. All western conifer species are hosts. Madrone (*Arbutus menziesii*) and a few brush species (*Arctostaphylos spp.* and *Artemisia tridentata*) are occasional hosts. Most hardwoods are apparently not infected. *Heterobasidion* root disease has been reported in all National Forests in California with incidence particularly high in true fir in northern California, in the eastside pine and in southern California recreation areas.

Heterobasidion root disease is one of the most important conifer diseases in Region 5. Current estimates are that the disease infests about 2 million acres of commercial forestland in California, resulting in an annual volume loss of 19 million cubic feet. Other impacts of the disease include: loss of tree vigor, increased susceptibility to attack by bark beetles, tree death, loss of site productivity, depletion of vegetative cover and increased probability of tree failure and hazard.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees or occasionally under the duff at the base of infected trees. New infection centers are initiated when airborne spores produced by the conks land and grow on freshly cut stump surfaces. In true fir spores also infect naturally-occurring and mechanical wounds. From infected stump surfaces the fungus grows into and through the roots, via root-to-root contact, to adjacent live host trees; resulting in the formation of expanding disease centers. A disease center can continue growing, host tree to host tree, until it reaches a barrier; such as an opening in the stand or non-host vegetation.

In pines, the fungus grows through root cambial tissue to the root crown where it girdles and kills the tree. In true fir and other non-resinous species, the fungus sometimes kills small trees, but more frequently is confined to the heartwood and inner sapwood of the larger roots; sometimes infecting the heartwood of the lower trunk. In all conifers, the fungus causes chronic decay and growth loss which predisposes infected trees to beetle attack and subsequent mortality.

Heterobasidion root disease in western North America is caused by two species: *Heterobasidion occidentale* (also called the 'S' type) and *H. irregulare* (also called the 'P' type). These two species of *Heterobasidion* have major differences in host specificity. *H. irregulare* ('Pine' type) is pathogenic on most pine species (but primarily on ponderosa and Jeffrey, sugar, lodgepole, pinyon and Coulter pines), incense cedar, western juniper, madrone and a few species of brush. *H. occidentale* ('Spruce' type) is pathogenic on true fir, Douglas fir, hemlock fir, spruce and giant sequoia. This host specificity is not apparent in isolates from stumps; with *H. occidentale* being recovered from both pine and true fir stumps. These data suggest that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for more than a quarter century. Young conifers established near infected stumps often die shortly after their roots grow in contact with infected roots.

The best control for *Heterobasidion* root disease is prevention; i.e. treating freshly cut conifer stumps with a borate fungicide. The two fungicides registered for this purpose are SPORAX® (granular) and CelluTreat® (liquid). Note: treatment of freshly-cut stumps will only protect healthy stumps and roots. In California, most true fir stands are already infected, to some degree, with *H. occidentale.* Borate stump treatment will not kill *Heterobasidion* already growing in the roots.

Once in the roots, *Heterobasidion sp.* can persist more than 25 years or until the roots decompose. As long as sound and wet wood, free of other microbes, is available, *Heterobasidion sp.* can survive. Therefore, the two primary controls for infected root systems are: 1) removing all host plants from the disease center for a quarter century, or until almost 100% of the roots have decomposed; or 2) removing all of the infected stumps and roots. The former may result in loss of site productivity

and/or require managing only non-host trees on the site. The latter is usually cost-prohibitive, except in nurseries, seed orchards, administrative sites, recreation areas or high-value sites.

True Fir Dwarf Mistletoe

True fir dwarf mistletoe, *Arceuthobium abietinum* f. sp. *magnificae* and *A. abietinum* f. sp. *concolor* are seed-bearing plants that parasitizes red and white fir, respectively. They are parasites that cannot survive without living host tissue, which they depend on for support, food, nutrients and water.

Dwarf mistletoes initiate their life cycle when a seed lands on a needle or small twig of a host. The seed is coated with viscin, a sticky substance that allows it to adhere to the host tissue. During rains, the viscin becomes mucilaginous, allowing the seed to slide down to the needle base where it may lodge. The seed germinates in the winter or spring and the radicle grows along the twig until it reaches a needle base or bark irregularity. The radicle forms a holdfast and penetrates the twig into the xylem. A type of root system then develops in the twig. In 3 to 5 years from seed deposition, most successful infections will appear as branch swellings and will bear mistletoe shoots. These shoots generally produce fruit 1 to 2 years later. Fruit mature in the fall and disseminate seed in September and October. The seeds are explosively discharged from the fruit through the buildup of turgor pressure. Seeds normally have an upward trajectory.

True fir dwarf mistletoe does not spread rapidly following establishment. Vertical spread in a tree averages less than 3 inches per year. Horizontal spread in a stand without overstory infection is also quite limited. The dense foliage of true firs limits spread because of the high probability of interception of the seed. Spread of dwarf mistletoe seeds from infected overstory to understory trees is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occassionaly vectored by birds and animals. Trees less than 3 feet tall have a very limited chance of infection because of their small target size.

Often the canker-causing fungus *Cytospora abietis* infects true firs at dwarf mistletoe infections. *Cytospora* sometimes attacks as many as a quarter of the mistletoe-bearing branches, eventually killing infected branches. The bright red/dead branches on most dwarf mistletoe-infected red firs (and sometimes white firs) are the result of lethal Cytospora infections. C. abietis occasionally reaches especially damaging proportions in certain years.